
DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Application of the Invention] This invention relates to the gradation method of presentation for obtaining the expression of an in-between color tone or a shade especially in the image display approach in the liquid crystal electro-optic device which used the thin film transistor (it is called Following TFT) as a switching element for a drive. Especially this invention relates to the so-called perfect digital gradation display which performs a gradation display, without impressing any analog signals to an active component from the exterior.
[0002]
[Description of the Prior Art] Since dielectric constants differ from the matter property to a horizontal direction and a perpendicular direction to a molecule shaft, to external electric field, it arranges horizontally or a liquid crystal constituent can perform making it have arranged perpendicularly enough easily. The liquid crystal electro-optic device is performing the display of ON/OFF, i.e., light and darkness, using the anisotropy of this dielectric constant by controlling the amount of transmitted lights or the amount of dispersion of light. As a liquid crystal ingredient, the ingredient called TN (twin SUTEDDO pneumatic) liquid crystal, STN (super twin SUTEDDO pneumatic) liquid crystal, a ferroelectric liquid crystal, antiferroelectricity liquid crystal, polymer liquid crystal, or distributed liquid crystal is known. It is known that liquid crystal will require fixed time amount which will exist by the time it reacts and answers short time amount to foreign voltage at infinity. The value is peculiar to each liquid crystal ingredient, and, in the case of TN liquid crystal, in the case of several 10 msec(s) and STN LCD, is [in the case of several 100 msec(s) and a ferroelectric liquid crystal] several 10 msec(s) in the case of several 10microsec, distributed process input output equipment, or polymer liquid crystal.
[0003] The active matrix was used for that from which the image quality which was most excellent among the electro-optic devices using liquid crystal is acquired. In the liquid crystal electro-optic device of the conventional active-matrix mold, TFT of the type of either P type or N type was used for one pixel at TFT using the semi-conductor of amorphous or a polycrystal mold, using a thin film transistor (TFT) as an active component. That is, generally the N channel mold TFT (it is called NTFT) is connected with the pixel at the serial. And when the signal was impressed to TFT prepared in the part where the signal line of a matrix and a sink and each signal line cross a signal level at right angles from both sides, it was what controls ON/OFF of a liquid crystal pixel according to an individual using TFT being in ON condition. By controlling a pixel by such approach, the large liquid crystal electro-optic device of contrast is realizable.
[0004]
[Problem(s) to be Solved by the Invention] However, in such an active matrix, it was very difficult to perform gradation displays, such as light and darkness and a color tone. Conventionally, the method using a gradation display changing the light transmission nature of liquid crystal with the magnitude of the electrical potential difference impressed was examined. This was what is going to apply the electrical potential difference of the magnitude to a liquid crystal pixel by supplying a suitable electrical

potential difference from a circumference circuit between the source drains of TFT for example, in a matrix, and impressing a signal level to a gate electrode in the condition.

[0005] However, also at the lowest by such approach, the electrical potential difference built over a liquid crystal pixel in fact for the heterogeneity of TFT or the heterogeneity of matrix wiring has changed also several% with each pixels, for example. On the other hand, for example, since the electrical-potential-difference dependency of whenever [light transmission / of liquid crystal] had very strong non-linearity and light transmission nature changed rapidly on a certain specific electrical potential difference, also in the difference which is several % even if, light transmission nature might differ remarkably. Therefore, it was a limitation to attain 16 gradation in fact. For example, in TN liquid crystal ingredient, when the so-called transition region where light transmission nature changes from ON condition to an OFF condition had only the width of face of 1.2V and 16 gradation was used as an achievement plug, control of the small electrical potential difference of 75mV which divided into 16 narrow electrical-potential-difference width of face called 1.2V needed to be completed, therefore the manufacture yield became remarkably low.

[0006] Thus, it was very disadvantageous for a gradation display to be difficult, when competing with CRT (cathode-ray tube) whose liquid crystal display unit is the conventional common display. This invention aims at proposing the completely new approach for realizing the difficult gradation display conventionally.

[0007]

[Means for Solving the Problem] Now, although it said previously that it is possible to control the light transmission nature by controlling in analog the electrical potential difference applied to liquid crystal, this invention people found out that gradation could be obtained visually by controlling the time amount which the electrical potential difference has required for liquid crystal.

[0008] For example, it turned out that it is possible to change brightness by impressing a wave electrical potential difference as shown in drawing 1 in the so-called Nor Marie Black, i.e., the pixel designed so that it may be in the condition that there is no light transmission nature (black), in the condition of not impressing an electrical potential difference to a liquid crystal pixel, to a pixel when TN (Twisted Nematic) liquid crystal which is a typical liquid crystal ingredient is used. namely, "1" of drawing 1 , "2", and ... it can be gradually made bright in the sequence "15." That is, in the example of drawing 1 ,. the display of 16 gradation is possible. "1" is the brightest and "15" is the darkest in Nor Marie White (light transmission nature is shown in the condition that the electrical potential difference is not impressed) which is the mode in which Nor Marie Black is reverse with a natural thing.

[0009] At this time, the pulse of the die length of one unit is impressed by "1." Moreover, the pulse of the die length of two units is impressed in "2." In "3", the pulse of one unit and the pulse of two units are impressed, and the pulse of the die length of three units is impressed as a result. The pulse of the die length of four units is impressed in "4." In "5", the pulse of one unit and the pulse of four units are impressed, and the pulse of two units and the pulse of four units are impressed in "6." Furthermore, the pulse of the die length of 15 units can be acquired as a result by preparing the pulse of the die length of eight units.

[0010] That is, the display of 24 = 16 gradation is attained by combining appropriately four kinds of pulses of one unit, two units, four units, and eight units. Furthermore, an altitude gradation display called 32 gradation, 64 gradation, 128 gradation, and 256 gradation is attained by preparing many pulses like 16 units, 32 units, 64 units, and 128 units, respectively. For example, what is necessary is just to prepare eight kinds of pulses, in order to obtain 256 gradation displays.

[0011] moreover, the persistence time of the electrical potential difference impressed to a pixel in the example of drawing 1 -- beginning T1 and a degree -- 2T1 and its degree -- 4T1 as -- although the arranged example was shown so that it might increase in geometrical progression -- this -- for example, drawing 3 -- like -- the beginning -- T1 and a degree -- 8T1 and its degree -- 2T1 and the last -- 4T1 ****** -- it is good. Thus, by making it arrange, the burden of the equipment which transmits data to an indicating equipment can be reduced.

[0012] If this invention is not carried out, as a liquid crystal ingredient, TN liquid crystal, STN LCD and

a ferroelectric liquid crystal, antiferroelectricity liquid crystal, and distributed (polymer) liquid crystal are suitable. Moreover, although it differed delicately by which liquid crystal ingredient the pulse width of one unit chooses, it became clear that 100 or less msec is suitable 10ns or more in the case of TN liquid crystal ingredient.
[0013] What is necessary is just to construct the matrix circuit which used the thin film transistor as shown in drawing 4 , in order to carry out this invention. The circuit shown in drawing 4 is the same as the circuit used for the active-matrix mold display using the conventional TFT. The example of one pixel of such a active-matrix mold display is shown in drawing 5 . In drawing, a field 12 shows NTFT (or PTFT) made for example, in polish recon, and an electrode 14 is the gate electrode. And wiring 11 is gate wiring and this functions as an X-ray. Moreover, wiring 10 is wiring linked to the source of TFT, and functions as a Y line. Moreover, wiring 15 is wiring for forming the capacitor in drawing 4 , and this is prepared through an insulating material in the bottom of the pixel electrode 13.
[0014] In drawing 4 , the capacitor is artificially inserted in the capacitor of a pixel, and juxtaposition. Through the parasitic capacitance between a gate electrode and a drain field, an X-ray carries out capacity coupling of it to a pixel electrode, and the capacitor inserted at this time also has the effectiveness which controls changing the potential of a pixel electrode by fluctuation of the potential of an X-ray while it has the effectiveness which controls that the electrical potential difference of a pixel falls by natural discharge of a pixel.
[0015] About especially the latter, in approximation, the magnitude of potential fluctuation is proportional to the parasitic capacitance between a gate, the source, and a drain, and in inverse proportion to the capacity of a liquid crystal pixel. In a liquid crystal display unit, to the ability to control the capacity of a pixel comparatively easily, dispersion in parasitic capacitance tends to become large, therefore when the capacity of a liquid crystal pixel is small, dispersion in the parasitic capacitance of a gate may influence greatly (for example, when the area of a liquid crystal unit pixel is small etc.), and a shade may completely become random by each pixel. It is an important problem when it is going to perform a gradation display as what has the electrical potential difference fixed like especially this invention which is impressed to a pixel and maintained. It is important to be, although carried out, to add capacity in this way, to enlarge capacity of a liquid crystal pixel seemingly, to suppress the effectiveness of the parasitic capacitance of a gate, and to make fluctuation of liquid crystal potential small.
[0016] Moreover, actuation which was stable to pixels, such as a liquid crystal cell, and excelled [pixels] in repeatability, without forming such an artificial capacitor by making the electrostatic capacity of a pixel increase and therefore making the time constant of discharge of a pixel increase by making organic ferroelectric materials, such as tetrafluoroethylene and poly vinylidene fluoride, contain can be carried out.
[0017] However, since it is leading to the fall of a working speed, as for adding an excessive capacity, it is not desirable to add a capacitor in this way. therefore, number [of the capacity of ten to 100 times of parasitic capacitance or liquid crystal pixel original of a gate] - 10 or less times is preferably suitable about 100 times. [magnitude / of the capacity to add]
[0018] In such a circuit, it is possible by controlling the gate voltage of each thin film transistor, and the electrical potential difference between source drains to control ON/OFF of the electrical potential difference impressed to a pixel. In this example, although the number of matrices was 640x480, in order to avoid complicatedness, it was shown only near the n line m train. A perfect thing will be obtained if the same thing as this is developed vertically and horizontally. The example of operation using this circuit is shown in drawing 2 .
[0019] signal lines X1 and X2 and .. Xn, Xn+1, and .. X480 (it is hereafter named an X-ray generically) -- every -- it connects with the gate electrode of TFT. And as shown in drawing 2 , a rectangular pulse signal is impressed in order. on the other hand -- signal lines Y1 and Y2 and .. Ym, Ym+1, and .. Y640 (it is hereafter named Y line generically) -- every -- although it connects with the source (or drain electrode) of TFT, the signal which consists of two or more pulses is too impressed to this. In this pulse train, it is the time amount T1 of one unit. 640 information is included in inside.
[0020] Below, it is four pixels Zn and m, Zn+1, m, Zn, m+1, Zn+1, and m+1. Since the electrical

potential difference which is a pixel unless a signal comes to the both sides of a gate electrode and a source electrode, although observed does not change, it is related with these four pixels, and it is a signal line Xn and Xn+1. And Ym and Ym+1 What is necessary is just to observe.
[0021] A rectangular pulse is Xn as shown in drawing. The case where it is impressed is considered. Now, four pixels Zn and m, Zn, m+1, Zn+1, m, Zn+1, and m+1 It is Ym if it is observing. And Ym+1 What is necessary is just to observe the condition at that time. this time -- Ym **** -- a signal -- it is -- Ym+1 **** -- since there is no signal -- after all -- pixels Zn and m An electrical-potential-difference condition, Zn, and m+1 It will be in a non-electrical-potential-difference condition. And since the electrical-potential-difference condition of a pixel is maintained by the capacitor of a pixel by cutting the pulse of an X-ray early rather than the electrical potential difference applied to Y line, they are Pixels Zn and m. An electrical-potential-difference condition is maintained. Henceforth, it is Xn next. The condition of each pixel continues fundamentally until a signal is impressed.
[0022] Subsequently, Xn+1 A pulse is impressed. Then, it is Ym as shown in drawing. A non-electrical-potential-difference condition and Ym+1 Since it is in an electrical-potential-difference condition, they are pixel Zn+1 and m. A non-electrical-potential-difference condition, pixel Zn+1, and m+1 It will be in an electrical-potential-difference condition, and maintaining each condition is continued the same with having stated previously.
[0023] Next, it is Xn previously. After a pulse is impressed, it is time amount T1. It is a signal line Xn behind. It is Ym when the 2nd pulse is impressed. And Ym+1 Since it is in a non-electrical-potential-difference condition and an electrical-potential-difference condition, they are Pixels Zn and m, respectively. To a non-electrical-potential-difference condition, it is Pixel Zn and m+1. A condition changes to an electrical-potential-difference condition, respectively. Furthermore, Xn+1 A pulse is impressed. Then, it is Ym as shown in drawing. Ym+1 Since it is in an electrical-potential-difference condition, they are pixel Zn+1 and m. Zn+1 and m+1 It will be in an electrical-potential-difference condition. At this time, pixel Zn+1 and m+1 will continue an electrical-potential-difference condition.
[0024] Then, time amount 4T1 Behind, the 3rd signal is Xn. It is impressed. Then, it is Ym. Ym+1 Since it is in an electrical-potential-difference condition, they are Pixels Zn and m. It changes from a non-electrical-potential-difference condition to an electrical-potential-difference condition, and is Pixel Zn and m+1. An electrical-potential-difference condition will be continued. Furthermore, Xn+1 A pulse is impressed. Then, it is Ym. Since Ym+1 is in a non-electrical-potential-difference condition, they are pixel Zn+1 and m. Zn+1 and m+1 It will be in a non-electrical-potential-difference condition, and an electrical-potential-difference condition will all be completed.
[0025] Then, time amount 2T1 Behind, the 4th signal is Xn. It is impressed. Then, it is Ym. Ym+1 Since it is in a non-electrical-potential-difference condition, they are Pixels Zn and m. Pixel Zn and m+1 It changes from an electrical-potential-difference condition to a non-electrical-potential-difference condition. Furthermore, Xn+1 Although a pulse is impressed, it is Ym too. Ym+1 Since it is in a non-electrical-potential-difference condition, they are pixel Zn+1 and m. Zn+1 and m+1 It is still a non-electrical-potential-difference condition.
[0026] Thus, one period is completed. In the meantime, three pulses are impressed to X lines each, and the information signal of 3x480=1440 is impressed to Y lines each. moreover, the time amount of this one period -- 1T1+2T1+4T1 =7T1 it is -- T1 ****** -- for example, 10ns - 10msec are suitable. and -- if each pixel is observed -- pixels Zn and m **** -- time amount T1 A pulse and 2T1 a pulse impresses -- having -- visual -- 3T1 The same effectiveness as that to which the pulse was impressed is acquired. That is, the brightness of "3" is obtained. the same -- Pixel Zn, m+1, pixel Zn+1, m, Zn+1, and m+1 **** -- the brightness of "4", "6", and "5" is obtained after all.
[0027] The Takashina tone is more possible by adding much more pulse signals in the above example, although the display of 8 gradation is possible. For example, the Takashina tone display of 256 gradation can be attained by adding 5 times of pulses to X lines each further, considering as a total of eight pulses, and impressing the information signal of 8x480=3840 to Y lines each into 1 period (one screen).
[0028] It is spacing of the pulse impressed to an X-ray in the example of drawing 2 to 4T1 and its degree

in T1 and a degree at first 2T1 It carried out. This method is close to the example of drawing 3 , and data transfer can be easily operated by doing in this way. Below, the configuration of a circumference circuit also including a data transfer is shown, and the profitableness of this invention is explained.
[0029] Drawing 6 shows the body of a display and the situation of a circumference circuit for carrying out this invention. In order to simplify explanation, matrix size of a screen was made into the small thing of 8x8. Considering as the description of this invention is having added the first in first out memory apparatus (henceforth FIFO) to the exterior of the driver of Y line. That is, by this FIFO, the data which should be supplied to Y line are stocked temporarily, and it outputs to Y line, i.e., a display, after that. Moreover, although the data impressed to Y line were an analog signal conventionally, in this invention, it is a digital signal. Conversely, since it was possible to have digitized a signal when saying, it can be said that FIFO was able to be added. Thus, by adding FIFO, the flow of a signal can be equalized and, therefore, the burden of the drive circuit before the shift register of drawing 6 can be mitigated.
[0030] It can be explained as the burden of a drive circuit as follows. That is, when the signal of Y line of drawing 2 is observed, it is T1 of the beginning. In between, no less than 480 information signals are impressed to Y line. However, the following 4T1 Although 480 signals are impressed also in between, since time amount has increased 4 times, a consistency is a quadrant. Moreover, the following 2T1 The consistency of the signal of a between is the one half of the first thing. Thus, when unevenness is in the consistency of a signal, a circuit must be designed based on the case of being the highest-density. Therefore, a shift register is TI. Processing 480 signals in between is called for.
[0031] However, T1 of the beginning The following 4T1 When data are mixed and are transmitted, it is 5T1. Since it is 960 signals at time amount, it is T1. What is necessary will be just to transmit the data of 192 hits. Then, FIFO can be prepared and the burden placed on a shift register can be mitigated by stocking data temporarily. It is like [if this compares and says] a dam. Since the water of a fixed flow rate is flowing into the dam and the water of a constant rate is always stored in the dam, according to down-stream need, the degree of freedom which emits water so much or emits it little by little is obtained.
[0032] Furthermore, it enabled it to control finely the shift register of an X-ray and Y line, and the timing of FIFO by the logic sequencer at drawing 6 .
[0033] Actuation of this invention is illustrated as follows. For example, as shown in drawing 7 , the signal inputted as a usual analog video signal is immediately made a digital signal by binary system data processing. For example, it considers as a 8 bits (8 figures) digital signal. In this example, 00011001 is changed for 10 of an analog signal and 00110011 and 100 are changed for 20 like 11111111, for example. The display of 28 = 256 gradation is attained by considering as 8 bits. Similarly, when 64 gradation is required and 6 bits and 16 gradation are required, it changes into a 4-bit signal. Moreover, for example, in 128 gradation displays, it is changed into a 7-bit signal.
[0034] Next, the signal changed in this way is temporarily accumulated in memory. However, each data at this time is not stored as a mass of 8-bit data. each 8-bit digit exception -- 20, 21, 22, 23, 24, 25, 26, and 27 the data distributed to a total of eight pieces, ********, #0, #1, #2, and # -- as superficial data called 3, #4, #5, #6, and #7 It distributes to the memory according to gradation for a gradation display, and is stocked. #0-#7 which wanted to know the data of the 1st line 2nd train of a matrix What is necessary is just to see the 2nd train of each of the 1st line of each data of bit. In this case, data called 0, 0, 0, 1, 1, 0, 0, and 1 are stocked by order from #7. Therefore, gradation data are 00011001, and if analogue conversion is carried out in the decimal number system, they will become the figure 10.
[0035] Thus, next, the stocked data are #0, as shown in drawing 8 . It is transmitted to the equipment of the next step sequentially from the 1st line of bit. When transmitted to the 8th line, it is #7 shortly. It is transmitted sequentially from the 1st line of bit.
[0036] #7 when a transfer of bit is completed, it is shown in drawing 9 -- as -- the following, (#1, #6), and (#2, #5) -- as -- (#3, #4) it is transmitted. It may be reverse and the sequence of this transfer may be this sequence of (#0, #7), (#6, #1), (#2, #5), and (#4, #3). make it any -- since it is at the output time of the data of #3 and #4 as it is shown later that the consistency of an image output becomes the highest in the combination of these data transfers, if it seems that other combination serves as a consistency lower

than this combination, especially a problem will not have it. Moreover, what is necessary is to make #7 which do not include image information at all as a dummy signal in this case, to carry out like a 8-bit signal seemingly, and just to perform the above combination, although it is changed into a 7-bit signal (#0, #1, #2, #3, #4, #5, #6) for example, as stated previously when performing 128 gradation displays. Furthermore, the combination of #6, (#0, #5), (#1, #4), and (#2, #3) may be made, and data may be transmitted without using a dummy.

[0037] Supposing it transmits data simply like #0, #1, #2, and ... when transmitting a 8-bit signal for example, it becomes an image output as shown in drawing 1 , and equalizes combining data with high output density, and low data, and technical thought of this invention of keeping a consistency low cannot be realized. Of course, even if it performs such data transfer, if processing of the signal in the latter part can fully carry out at high speed, it will be satisfactory in any way.

[0038] Now, the data transmitted in this way are distributed to each train of Y line by the shift register, and are inputted into FIFO. In FIFO, the data inputted previously are sent previously one by one, exactly, it is sent to a LCD driver so that a gelidium jelly may be extruded, and it is outputted to Y lines each. This situation is shown in drawing 10 . The rate is not fixed although it described previously that a gelidium jelly type extruded. At the example of drawing 10 , it is #0. #7 after the data of bit were extruded It is #1, after the data of bit are extruded and placing time amount for a while. The data of bit are extruded. The situation is shown in drawing 11 .

[0039] At drawing 11 , it is SL. The signal of the X-ray shown by 0-7, and DL The situation of the signal of Y line shown by 0-7 and the data transfer to Y line is shown. When the data of #0 are outputted to Y line at first, the data of #7 and #1 are stocked by FIFO. # Although the output of 0 is ended by time amount T and #7 are outputted succeedingly, also end it by time amount T. And the data of #7 are held among time amount 127T and on a screen matrix. The data of #2 are inputted into this time amount to which #0 and #7 are outputted via a shift register at FIFO following #6 and it. The time amount which it takes is 12T and total 24T, respectively. Therefore, when the data of #1 were outputted, 1/12 of the data of #6 did not pass to having been inputted into FIFO, but even when the data of #7 were outputted, 1/6 of the entry of data of #6 was completed. The data of #7 are displayed on these entries of data on the screen, and the time amount by which a LCD driver is not moving is mainly used. Since the circuit (for example, a shift register and each memory according to gradation for a gradation display) of the preceding paragraph of FIFO can operate rather than a LCD driver at a low speed, it is light and ends, so that clearly from this. [of the burden]

[0040] Then, the data of #1 are outputted, time amount T is placed after data output completion, and the data of #6 are outputted. And since an opening is made to FIFO by having outputted the data of #1, the following #5 and the data of #3 are inputted. The time amount which this input takes is 24T as well as having required for the entry of data of #6 and #2.

[0041] Thus, the data of #3 and #4 are inputted into FIFO, it is outputted from a LCD driver, one period is completed, and one screen of 256 gradation displays is formed of this. As mentioned above, this is determined by the output time amount of the data of #3 and #4 although the entry-of-data time amount to FIFO was per bit and 12T. That is, after it is held between 7T after the data of #3 stocked by FIFO were outputted by time amount T as shown in drawing, then the data of #4 are outputted by time amount T, it is held between 15T. In the meantime, it is the time amount of 24T. This time amount is shorter than the data maintain period of what kind of other combination. Therefore, since the data of #7 and the data of #1 must be inputted into FIFO, the maximum of a rate which transmits data to FIFO is determined per bit and as 12T in the meantime. Of course, data may be transmitted more for a short time.

[0042] In the above explanation, although FIFO was a 24x8-bit thing, if this is determined by the scale of the matrix of a display and is NxM, it is 3xNxM.

[0043] Since it is necessary to perform time sharing finely, by the Takashina tone display, as for circuits, such as an active component (TFT), a shift register, a LCD driver, and FIFO, high-speed switching is extremely needed, so that clearly from the above explanation. For example, since it is necessary to let out an animation per second 30 or more sheets, in order to realize 256 gradation, it is 256T1 <30msec,

i.e., T1 < 100microsec. Since it follows, for example, 480 signals need to be outputted to Y lines each between 100microsec(s) when the number of X-rays (it has connected with a gate electrode) is 480, and X lines each also need to follow the rate and it is necessary to drive TFT, it is required to impress the pulse for 200 or less ns, and for TFT to be also able to answer such a pulse after all. In the example of drawing 2 , although only TFT of NMOS was used, the circuit which has a CMOS circuit may be connected to a pixel in order to gather a working speed. For example, a CMOS inverter circuit, a CMOS deformation inverter circuit, a CMOS deformation buffer circuit, or a CMOS deformation transfer gate circuit may be used.

[0044] Furthermore, although the above explanation did not describe at all the so-called alternating current-ization which is made to reverse the sense of the electrical potential difference periodically built over liquid crystal for every screen and every number screen, and prevents degradation of the liquid crystal by electrolysis etc. by impressing direct current voltage to liquid crystal for a long time Since it is not contradictory to this invention, it is clear that alternating current-ization may be performed and this invention may be carried out.

[0045] Moreover, it is possible by impressing the suitable bias voltage for the counterelectrode of a pixel to change the substantial electrical potential difference concerning a pixel ingredient. for example, the sense of the electrical potential difference impressed to a pixel ingredient by impressing a suitable electrical potential difference to the counterelectrode of a pixel -- both positive/negative -- it can get picking. Such actuation is required in a ferroelectric liquid crystal.

[0046] Moreover, although the screen of one line was scanned at a time in order in the above explanation, it cannot be overemphasized that it is also possible to adopt the so-called interlaced-scanning method scanned one line or every multi-line.

[0047]

[Example] The equipment at the time of driving actual monochromatic television (NTSC) is shown in drawing 12 and drawing 13 , and drawing 15 using this invention, and the example of a driving signal is shown in drawing 14 and drawing 16 .

[0048] Drawing 12 shows the screen part and its circumference circuit of television, and the magnitude of the matrix of a screen is 720x480. Therefore, FIFO is 720x480x3=1036800 bit, and the number of the drivers and shift registers of 480 dots and Y line of the driver and shift register of an X-ray is 720. Furthermore, the data shift register of Y line used the thing of 16 bit x45. Such timing was controlled by the LCD gradation drive sequence controller.

[0049] The CMOS (**** type electric field effect component) transfer gate circuit was used for the matrix of a screen using poly-Si TFT. The circuit diagram about the four pixels is shown in drawing 15 . About production, the usual low-temperature heat annealing crystallizing method was adopted. It omits about the detail. In order to carry out high-speed operation of such a circuit efficiently, as shown in drawing 16 , it is good for the X-ray connected to the control electrode to impress the pulse signal (henceforth a bipolar pulse) which a polarity reverses. At this time, the polar sequence of a bipolar pulse, the height of a pulse, and the width of face of a pulse are designed according to the property of a component. Although the example of a transfer gate circuit of operation is shown in drawing 16 , fundamentally, it is the same as the case where the usual NMOS mold circuit is used, except using a bipolar pulse.

[0050] Drawing 13 shows the block diagram of the signal-processing part of television. It is changed into a 8-bit digital video signal by the analog to digital converter (A/D8bit) after the usual analog video signal is detached a synchronized part. This signal After being accumulated in the 720dotx480dotx8bit dual port memory which functions as reading storage according to gradation for a gradation display temporarily, in sequence like drawing 9 It is sent out to FIFO (it differs from surrounding FIFO of a matrix) of the next step, and is outputted to the Data input terminal of drawing 12 via a data set shift register from this FIFO. About these circumference circuits, the driver output terminal was altogether connected to the X-ray and Y line by the well-known TAB method using the monolithic IC.

[0051] However, it is also possible to produce the circumference circuit of a matrix especially a driver, FIFO, and a shift register by polish recon to a matrix and coincidence. In that case, since the process of

connection of many X-rays and Y line is not required, the yield of a product is made to be able to improve and a price can be reduced.

[0052] The signal added to a circuit is shown in drawing 14 . Pulse width of the signal added to an X-ray was set to 135ns. Since the 16-bit data bus was used for the transfer to the data shift register of data, the pulse of 21600 clocks was used for the transfer of the data per bit (720x480). The data transfer time per bit was set to 780microsec, for example, made it the condition that only 3micro sec did not add a signal, between the data of #6, and the data of #2. The frequency of data for that was 27.7MHz. The monochrome image of 256 gradation was able to be acquired with liquid crystal equipment as mentioned above.

[0053]

[Effect of the Invention] In this invention, it is characterized by performing the gradation display of a digital method to the gradation display of the conventional analog form. As the effectiveness, for example, the thing for which it varies and the property of all a total of 256,000 TFT(s) is produced that there is nothing when the liquid crystal electro-optic device which has the number of pixels of 640x400 dots is assumed As opposed to 16 gradation displays being considered to be limitations, if it has difficulty very much and mass-production nature and the yield are actually taken into consideration like this invention By indicating by gradation only by digital control purely, the gradation display beyond 256 gradation displays was attained, without adding an analog--completely signal. Since it was perfect digital display, even if the ambiguity of the gradation by property dispersion of TFT was completely lost, therefore dispersion in TFT had it a little, the very homogeneous gradation display was possible for it. Therefore, conventionally, since dispersion in the property of TFT would not be made a problem so much by this invention to whose yield having been very bad in order to obtain TFT with little dispersion, the yield of TFT was able to improve and was also able to hold down production cost remarkably.

[0054] For example, since about **10% of property dispersion of TFT existed when the usual analog gradation display is performed to the liquid crystal electro-optic device which created 256,000 sets of TFT(s) of 640x400 dots on 300mm square, 16 gradation displays were limitations. However, since it is hard to be influenced of property dispersion of a TFT component when the digital gradation display by this invention is performed, it became possible to 256 gradation displays, and the display of color variegated [what and 16,777,216 colors] and delicate has been realized in color display. When projecting software like television imagery, tints differ delicately [the "rock" which consists of the same color] from the detailed hollow etc. When it is going to perform the display near natural color, 16 gradation takes difficulty. The gradation display by this invention enabled it to attach change of these detailed color tones.

[0055] Although explanation was added in the example of this invention focusing on TFT which used silicon, TFT using germanium can be used similarly. Since the electron mobility of single crystal germanium exceeds 3600cm2 / Vs and especially Hall mobility has exceeded the property of 2/Vs, and the value (they are 2/Vs 480cm at 1350cm2 / Vs, and Hall mobility in electron mobility) of single crystal silicon 1800cm, it is the ingredient which was extremely excellent when performing this invention as which high-speed operation is required. Moreover, the temperature of germanium which changes from an amorphous state to a crystallized state is low compared with silicon, and it has turned to the low-temperature process. Moreover, a big crystal is obtained when the rate of karyogenesis in the case of crystal growth generally carries out polycrystal growth small therefore. Thus, even if it compares germanium with silicon, it has the equal property.

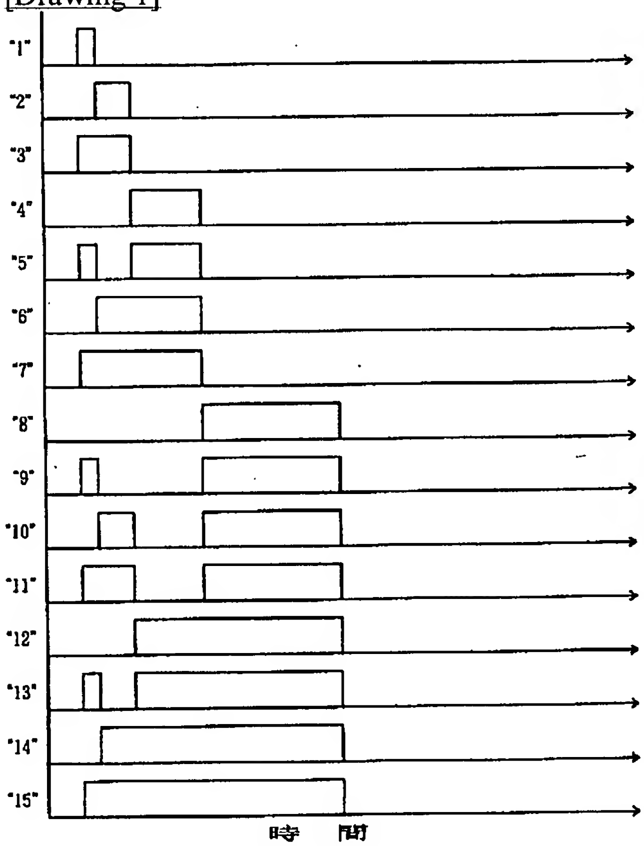
[0056] In order to explain the technical thought of this invention, explanation was added by making into an example the electro-optic device which mainly used liquid crystal, especially a display, but in order to apply the thought of this invention, nothing needs to be the display of a direct viewing type and you may be the so-called projection mold television and the other so-called optical switches, and an optical shutter. Furthermore, if an optical property also changes an opto electronics material in response to the electric effects not only of liquid crystal but electric field, an electrical potential difference, etc., it will be clear that this invention is applicable. Furthermore, probably, it will be clear that this invention is

applicable in addition to the actuation used by the above explanation also about the gestalt of liquid crystal of operation even if it is use with other modes, for example, use with guest host mode.

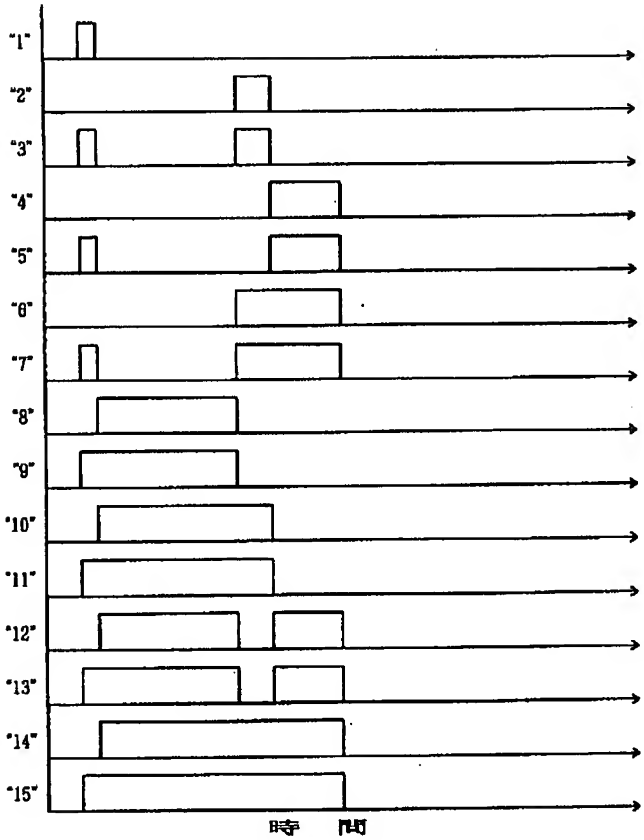
[Translation done.]

DRAWINGS

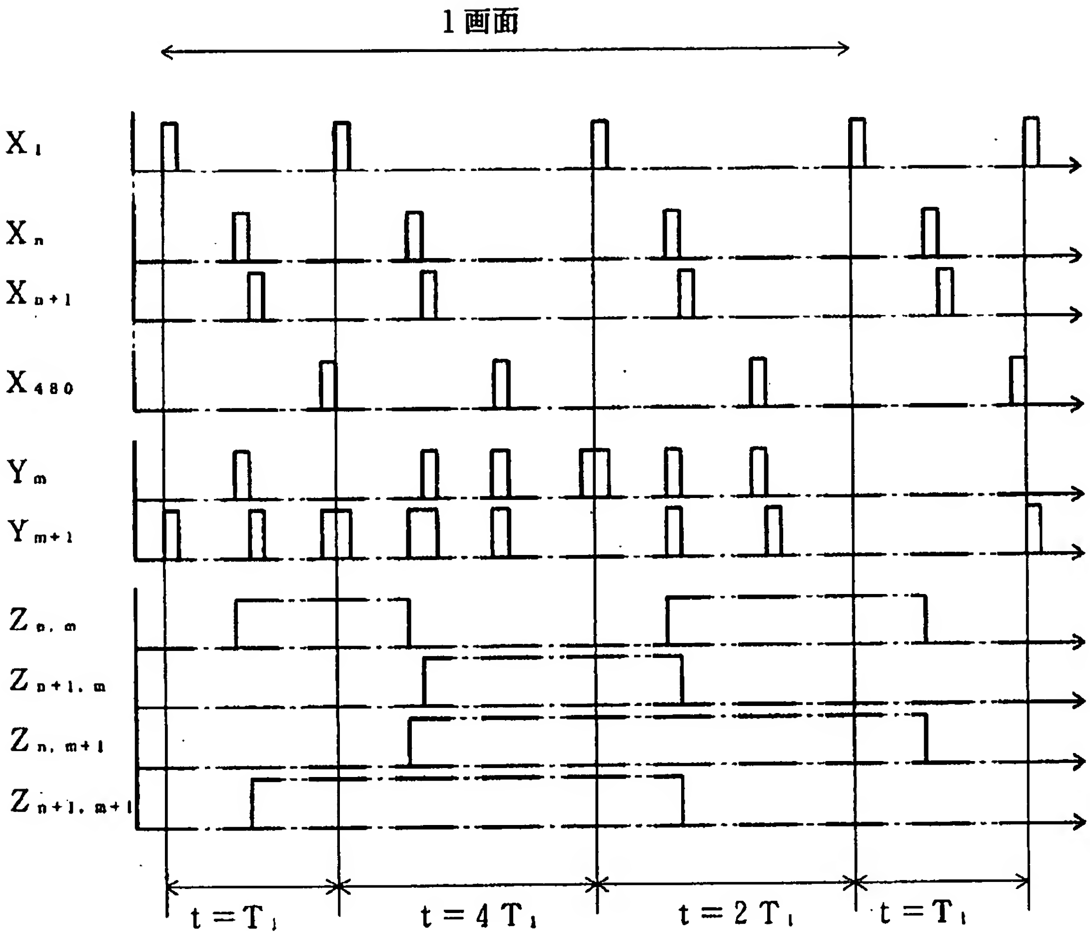
[Drawing 1]



[Drawing 3]

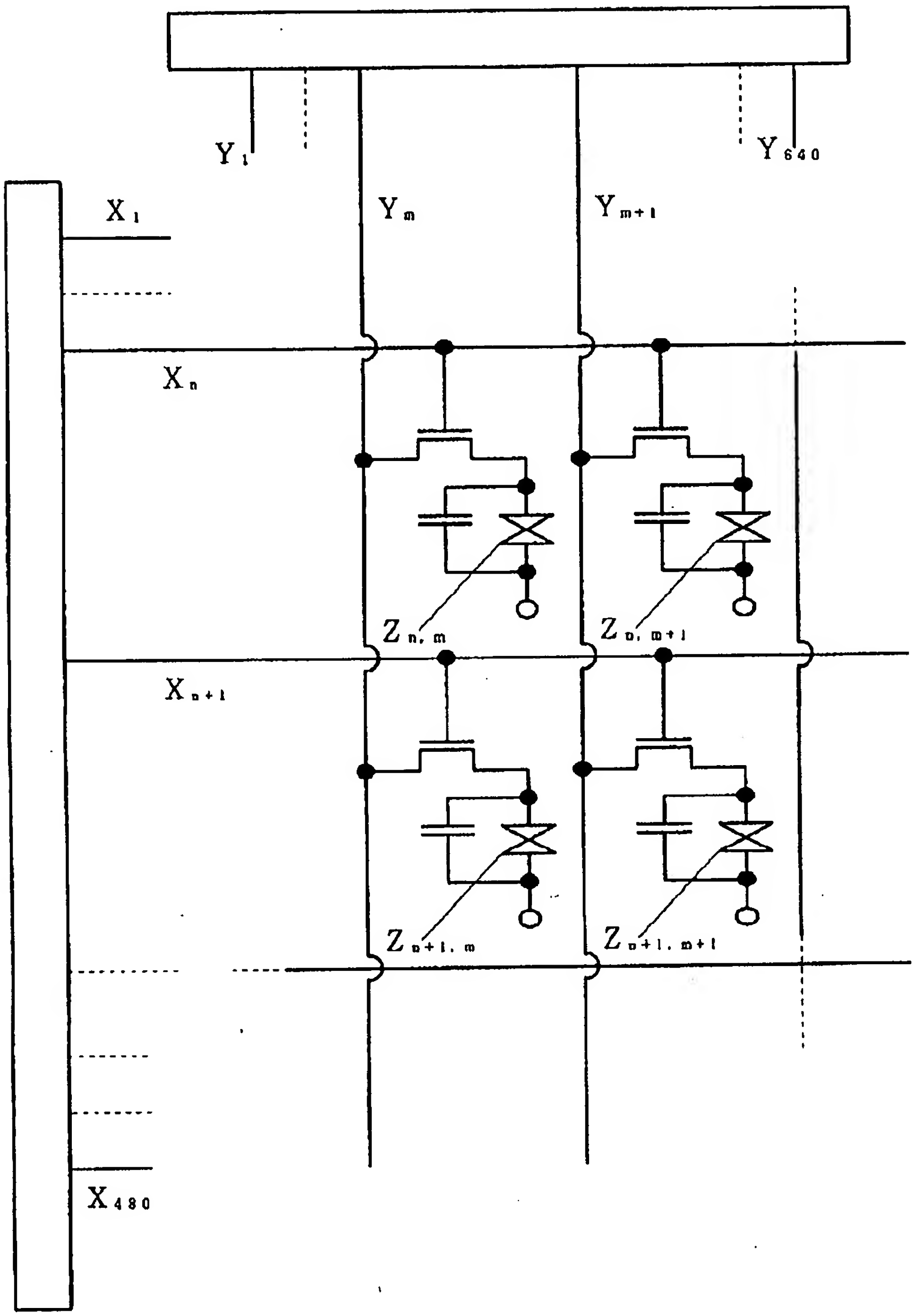


[Drawing 2]

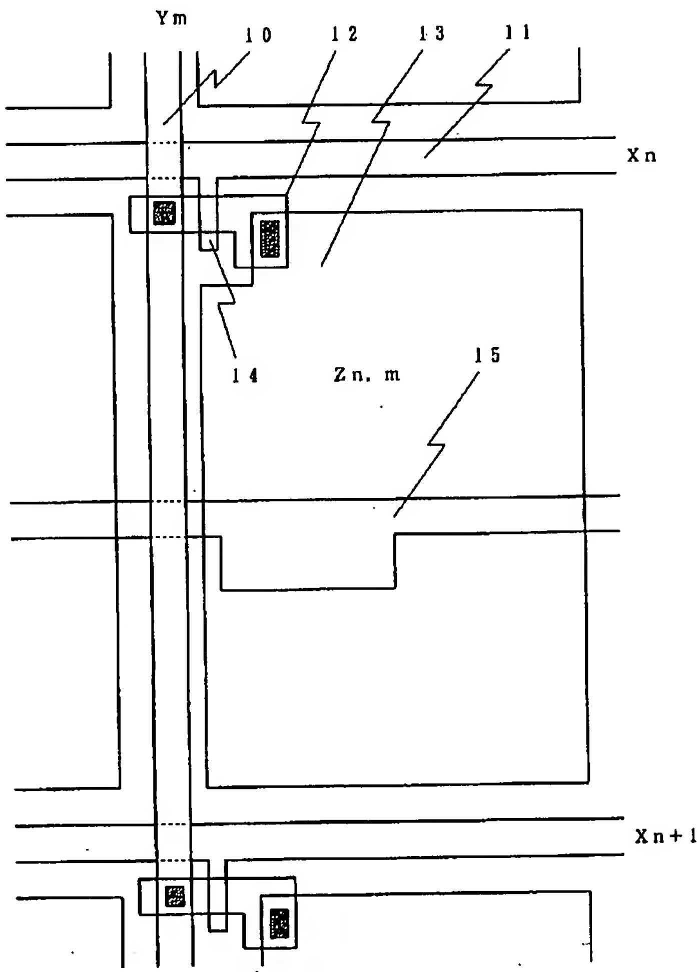


$Z_{n,m}$: $T_1 + 2T_1 = 3T_1$ → "3"
$Z_{n+1,m}$: $4T_1$ → "4"
$Z_{n,m+1}$: $4T_1 + 2T = 6T_1$ → "6"
$Z_{n+1,m+1}$: $T_1 + 4T_1 = 5T_1$ → "5"

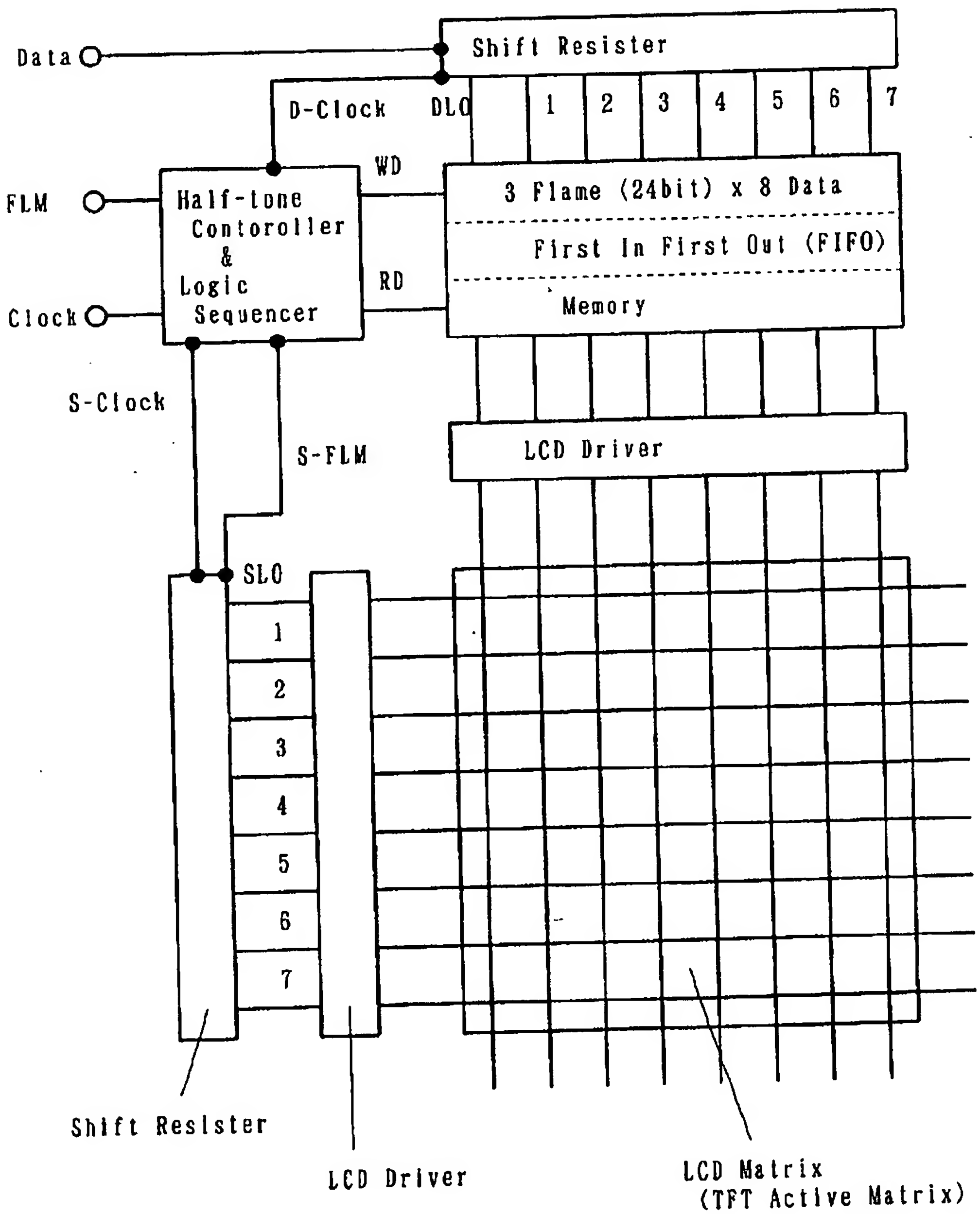
[Drawing 4]



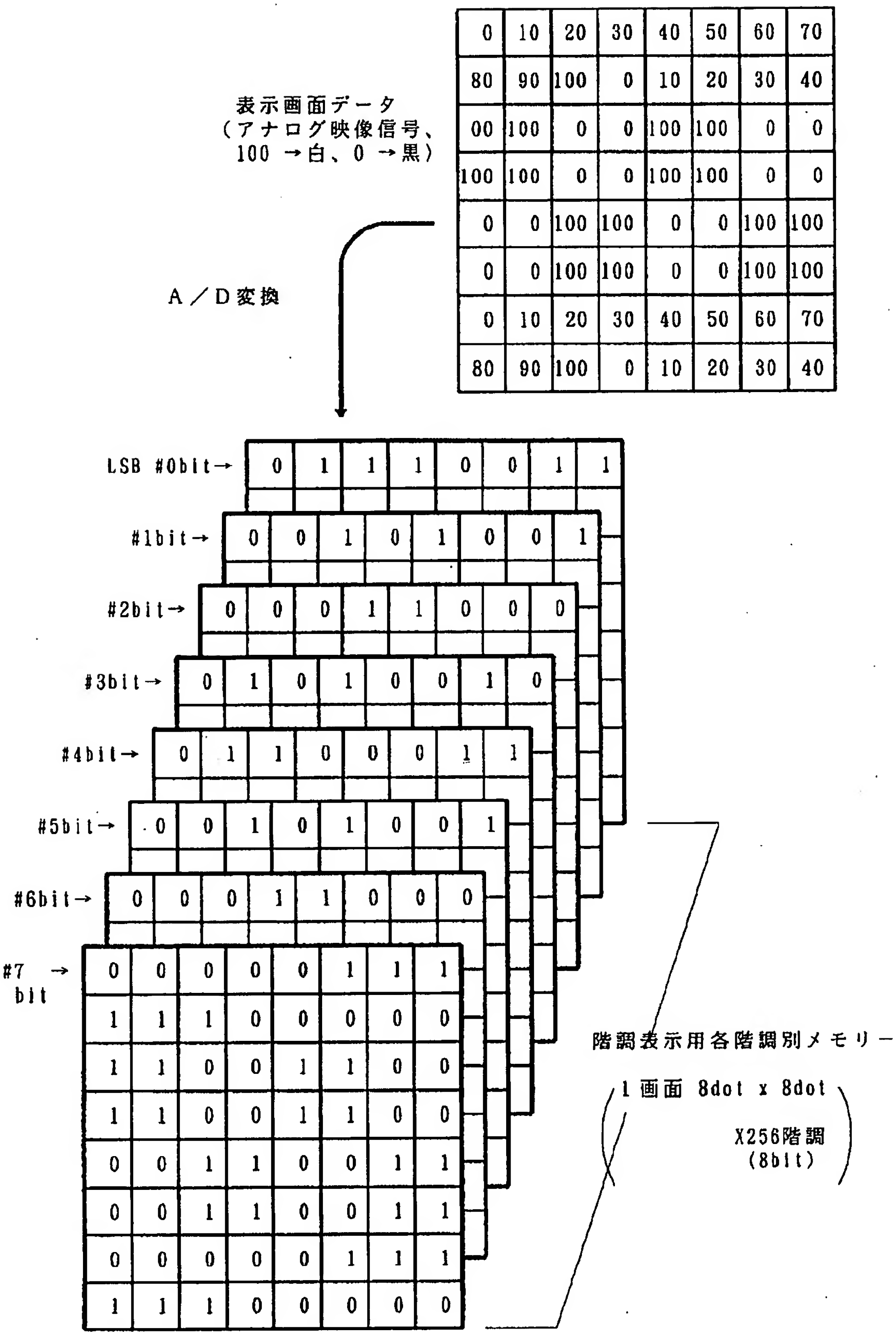
[Drawing 5]



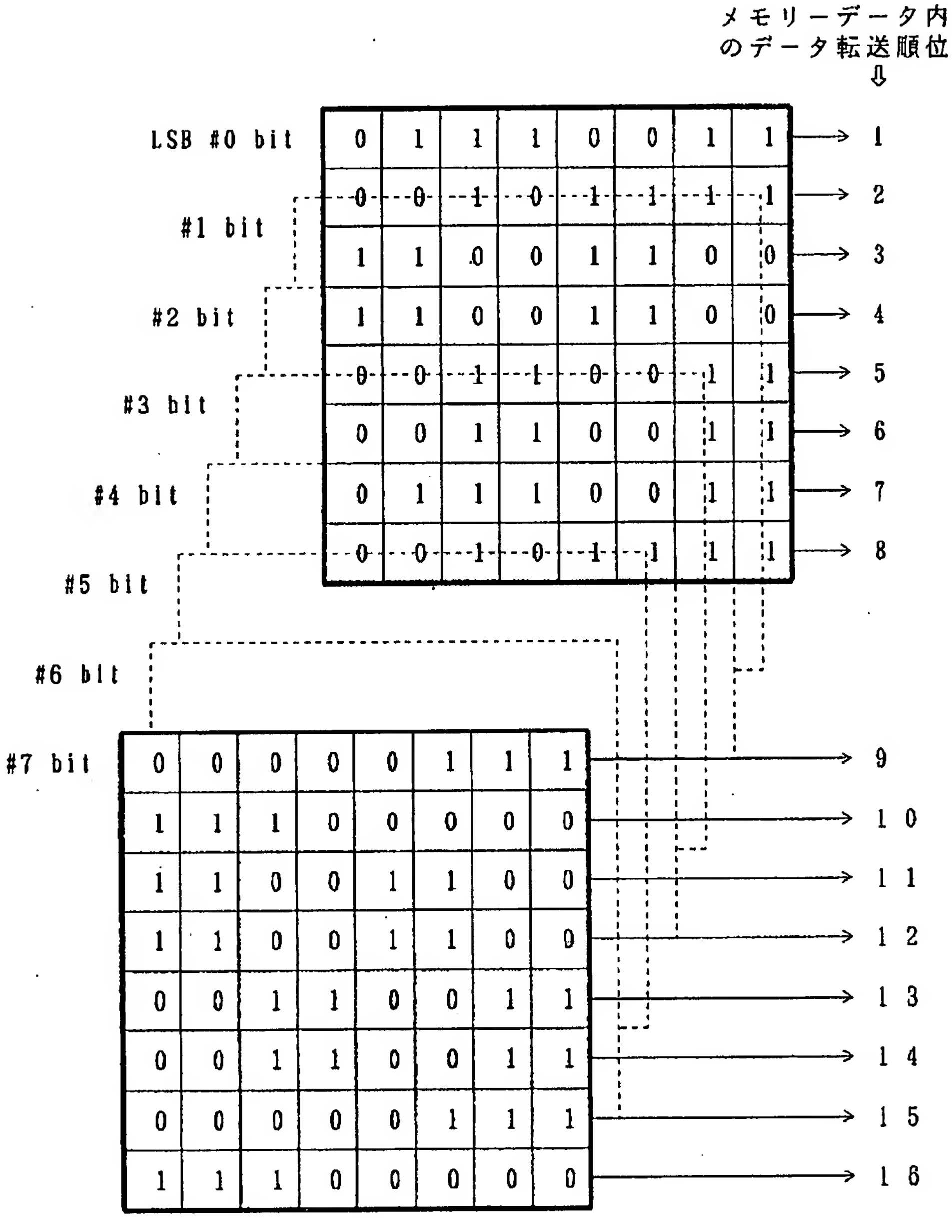
[Drawing 6]


Data
Shift Resister
D-Clock
DLO
1
2
3
4
5
6
7
WD
FLM
Half-tone Contoroller & Logic Sequencer
3 Flame (24bit) x 8 Data
First In First Out (FIFO)
Memory
RD
Clock
S-Clock
S-FLM
LCD Driver
SLO
1
2
3
4
5
6
7
Shift Resister
LCD Driver
LCD Matrix (TFT Active Matrix)

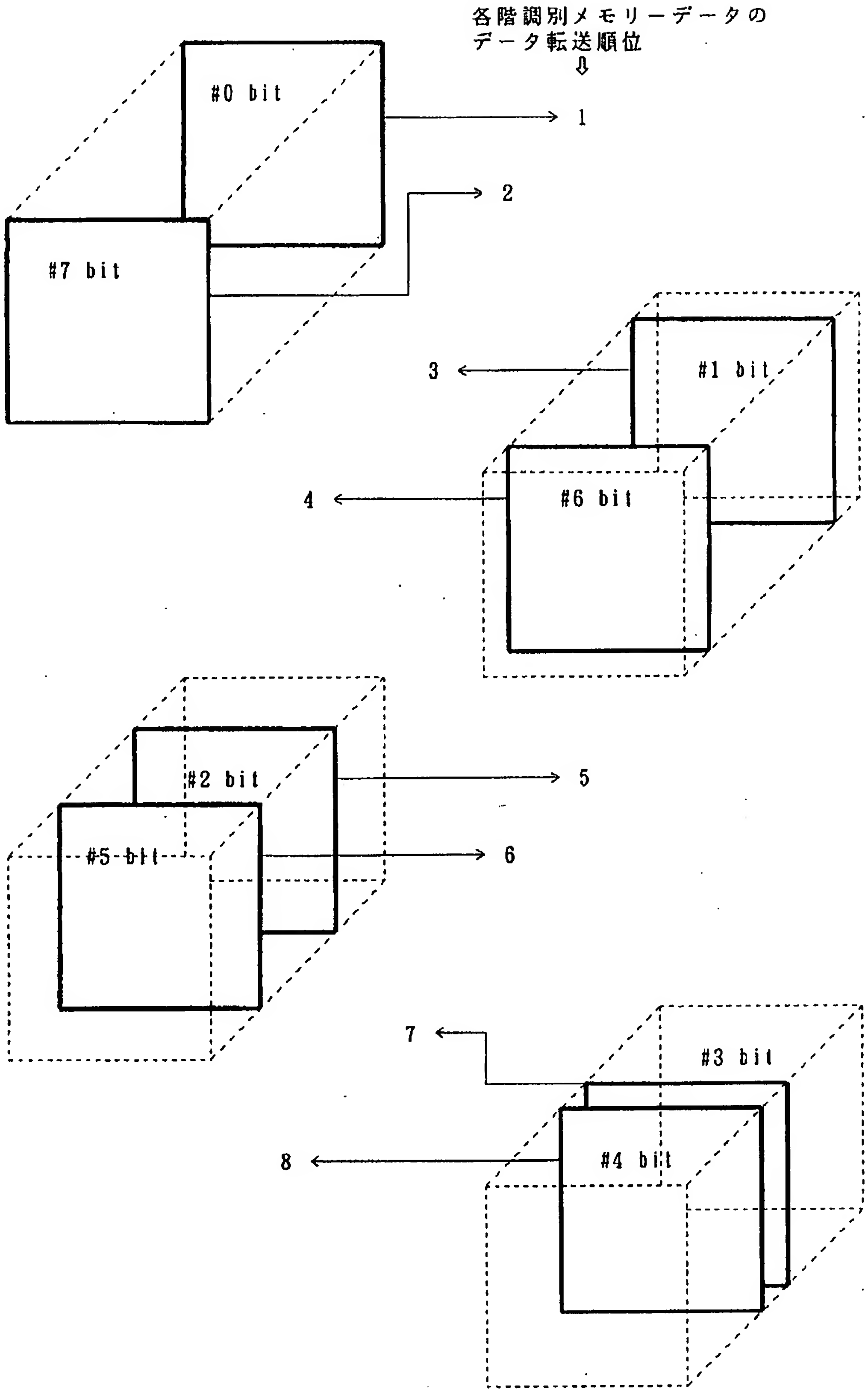
[Drawing 7]


表示画面データ
（アナログ映像信号、
100 →白、0 →黒）
A／D変換
LSB #0bit→
#1bit→
#2bit→
#3bit→
#4bit→
#5bit→
#6bit→
#7 → bit
階調表示用各階調別メモリー
1画面 8dot x 8dot
X256階調
(8bit)

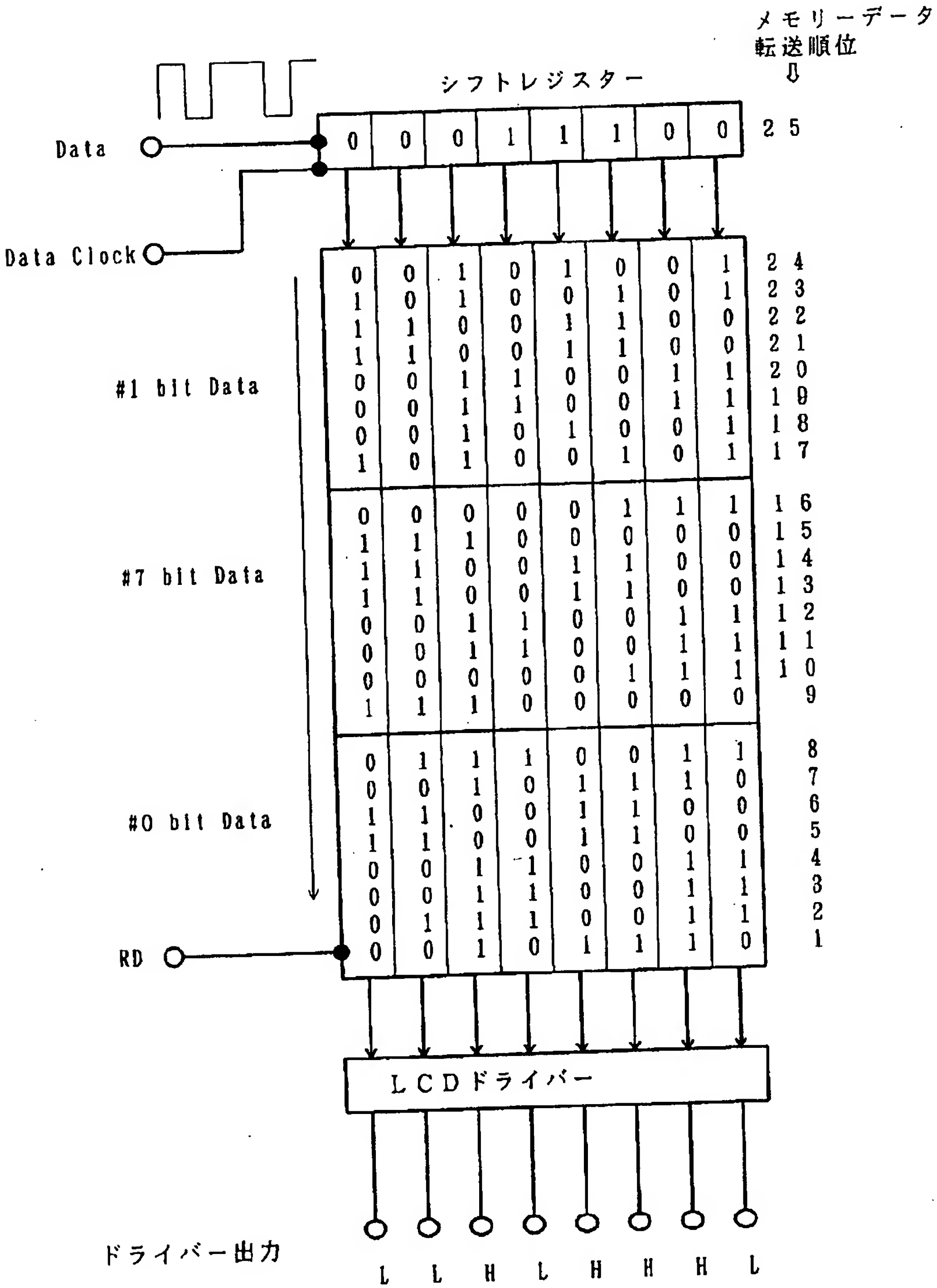
[Drawing 8]


メモリーデータ内
のデータ転送順位
LSB #0 bit
#1 bit
#2 bit
#3 bit
#4 bit
#5 bit
#6 bit
#7 bit
0 1 1 1 0 0 1 1
0 0 1 0 1 1 1 1
1 1 0 0 1 1 0 0
1 1 0 0 1 1 0 0
0 0 1 1 0 0 1 1
0 0 1 1 0 0 1 1
0 1 1 1 0 0 1 1
0 0 1 0 1 1 1 1
0 0 0 0 0 1 1 1
1 1 1 0 0 0 0 0
1 1 0 0 1 1 0 0
1 1 0 0 1 1 0 0
0 0 1 1 0 0 1 1
0 0 1 1 0 0 1 1
0 0 0 0 0 1 1 1
1 1 1 0 0 0 0 0
1
2
3
4
5
6
7
8
9
1 0
1 1
1 2
1 3
1 4
1 5
1 6

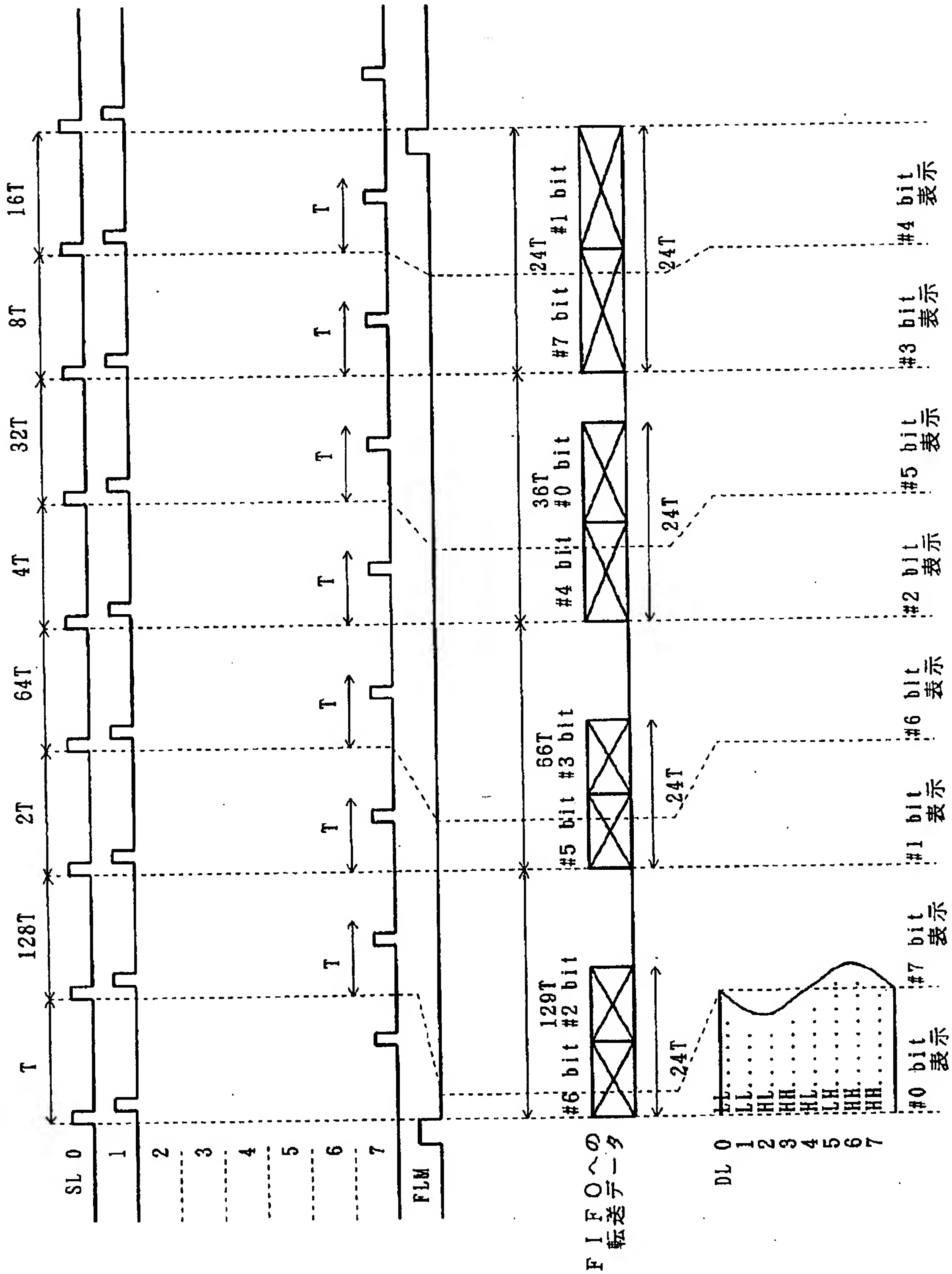
[Drawing 9]


各階調別メモリーデータの
データ転送順位
⇩
#0 bit
1
2
#7 bit
#1 bit
3
4
#6 bit
#2 bit
5
#5 bit
6
7
#3 bit
8
#4 bit

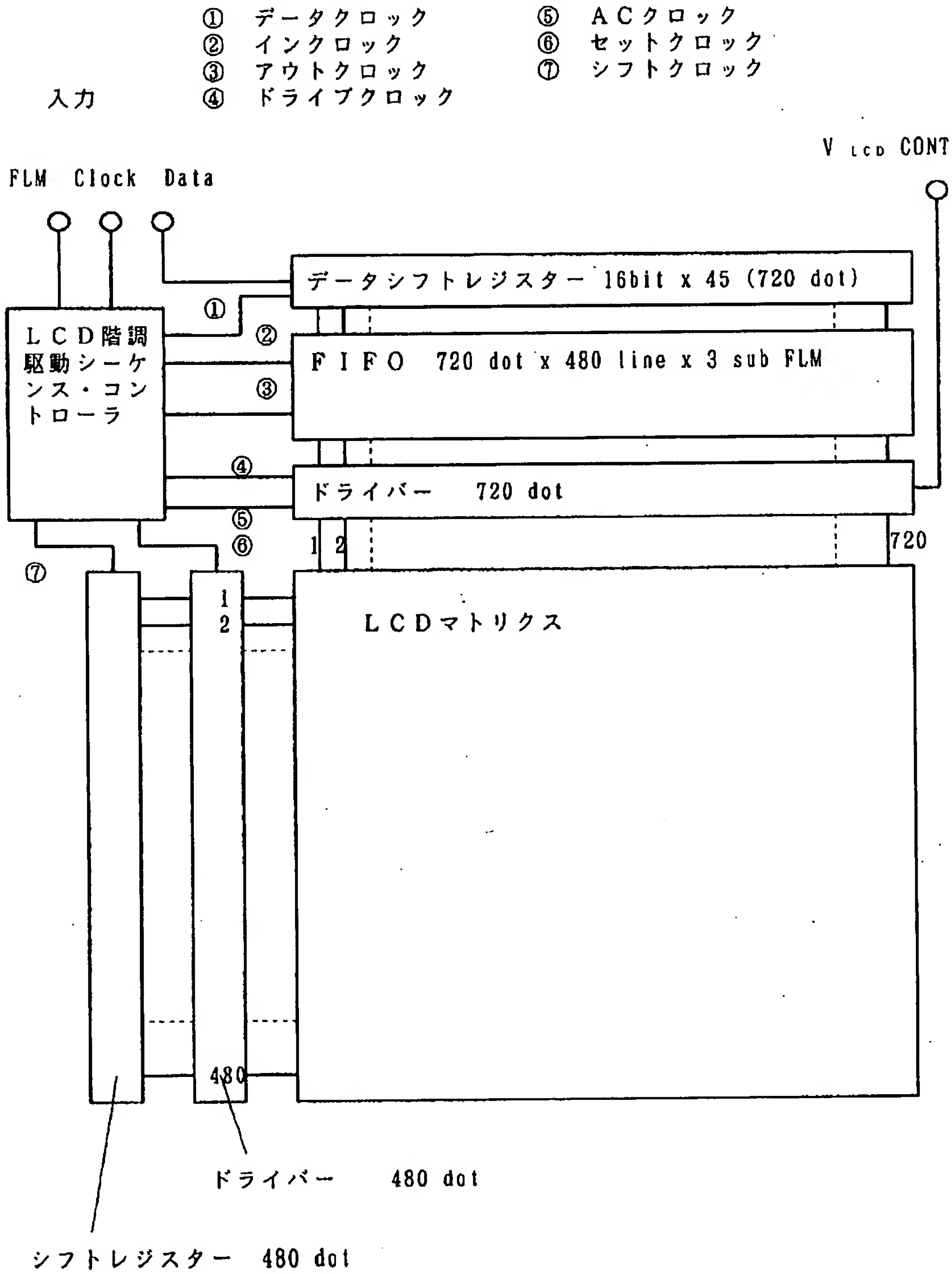
[Drawing 10]


メモリーデータ
転送順位
シフトレジスター
Data
Data Clock
#1 bit Data
#7 bit Data
#0 bit Data
RD
LCDドライバー
ドライバー出力
L L H L H H H L

[Drawing 11]

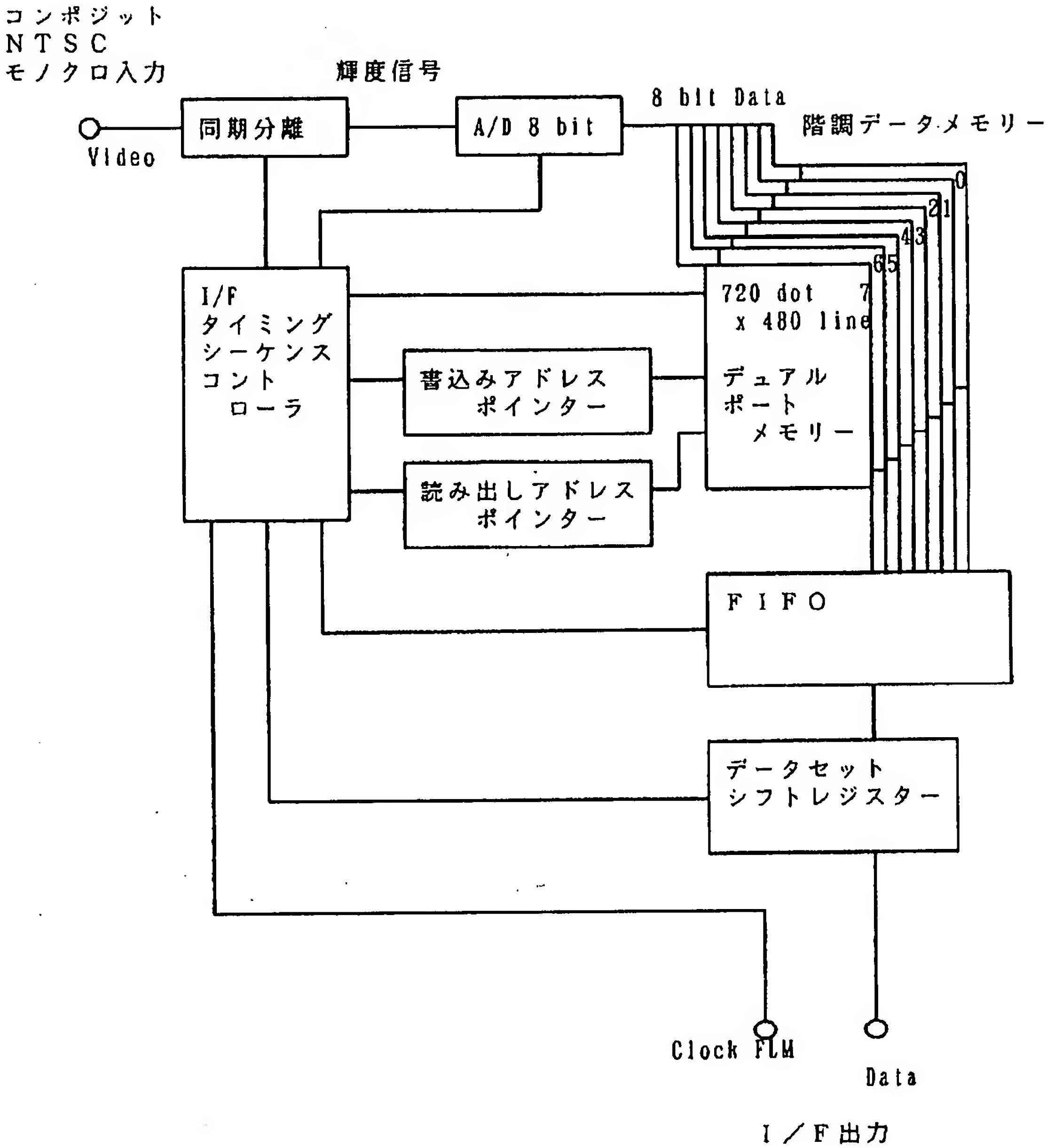

SL 0
1
2
3
4
5
6
7
FLM
FIFOへの転送データ
DL 0
1
2
3
4
5
6
7
T
128T
2T
64T
4T
32T
8T
16T
129T
66T
36T
24T
#6 bit #2 bit
#5 bit #3 bit
#4 bit #0 bit
#7 bit #1 bit
#0 bit 表示
#7 bit 表示
#1 bit 表示
#6 bit 表示
#2 bit 表示
#5 bit 表示
#3 bit 表示
#4 bit 表示
LL
LL
HL
HH
HL
LH
HH
HH

[Drawing 12]



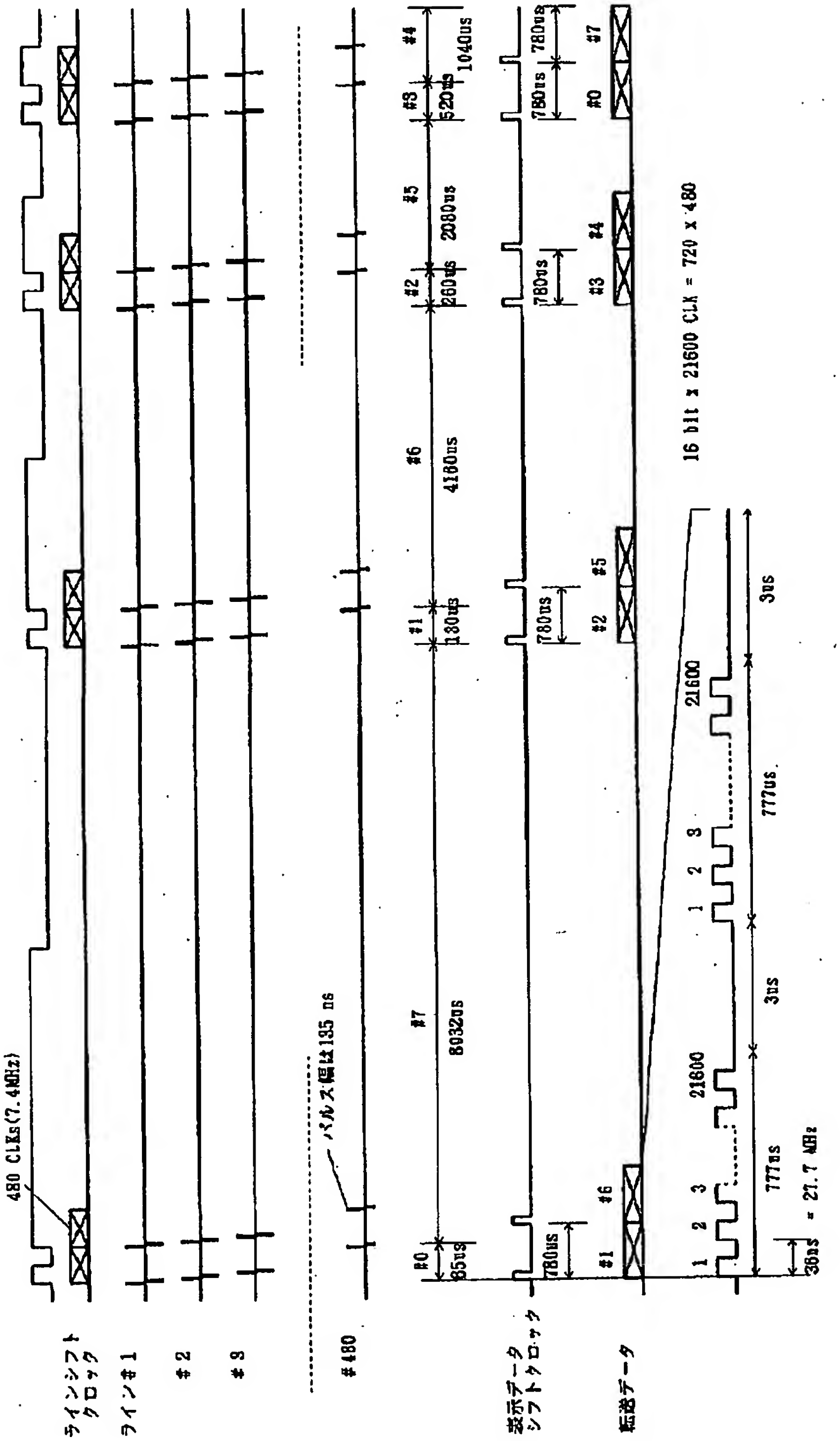
７２０×４８０ドットモノクローム２５６階調ＬＣＤ駆動回路ブロック図

[Drawing 13]



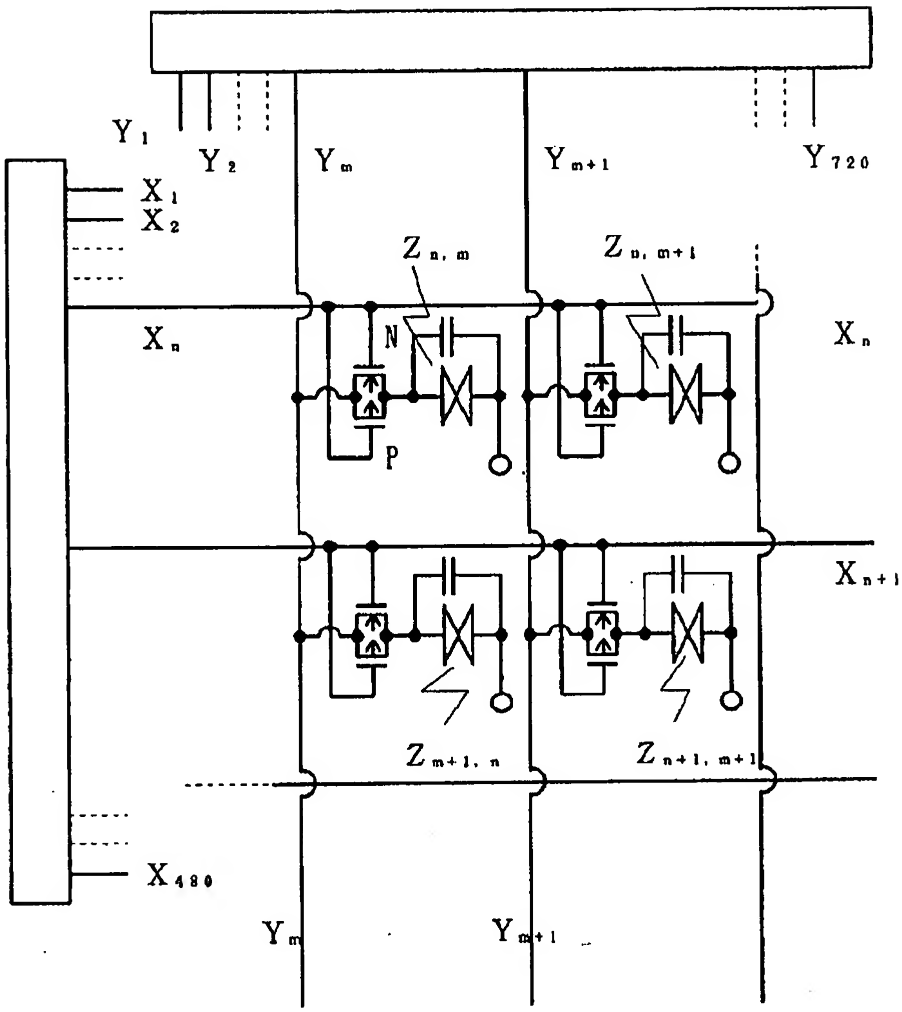
７２０×４８０ドット２５６階調ＬＣＤとＮＴＳＣモノクロ信号のＩ／Ｆ回路

[Drawing 14]

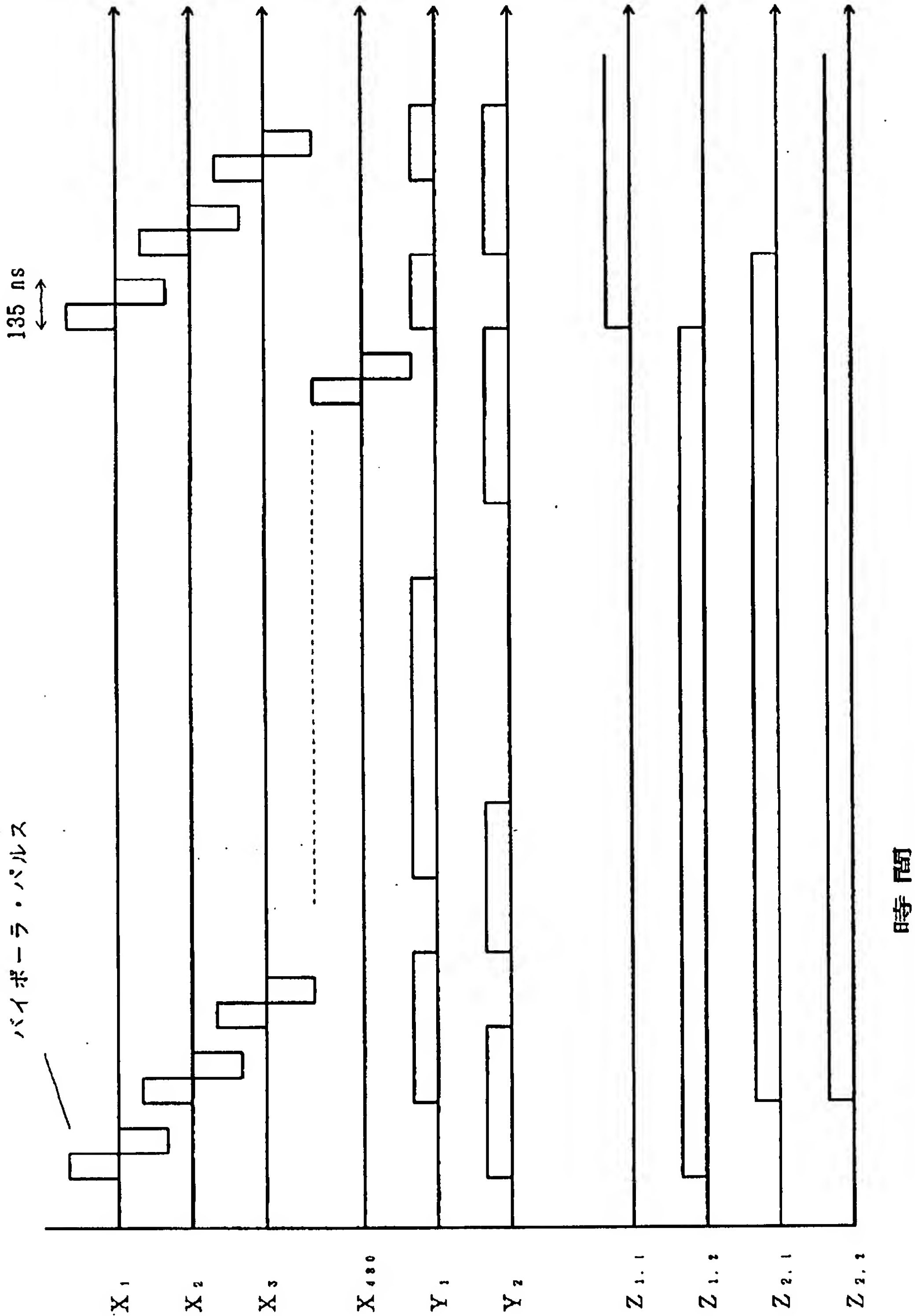


480 CLKs(7.4MHz)
パルス幅は135 ns
ラインシフトクロック
ライン#1
#2
#3
#480
表示データシフトクロック
転送データ
#0
#1
#2
#3
#4
#5
#6
#7
65us
130us
260us
520us
1040us
2080us
4160us
8032us
780us
16 bit x 21600 CLK = 720 x 480
21600
777us
3us
36ns = 27.7 MHz

[Drawing 15]


Y1
Y2
Ym
Ym+1
Y720
X1
X2
Zn, m
Zn, m+1
Xn
N
Xn
P
Xn+1
Zm+1, n
Zn+1, m+1
X480
Ym
Ym+1

[Drawing 16]



[Translation done.]